ENGINEERING CASE LIBRARY

ECL 233

CAMERA INSTALLATION IN HELIO COURIER AIRCRAFT (A)

To accommodate a survey camera, the fuselage structure of the Helio Courier light aircraft must be modified. This case documents the analysis made by H. Aass Aero Engineering to ensure that the modifications complied with MOT requirements.

Written by P. A. Moylan , Chief Designer, H. Aass Engineering under the direction of Professor G. Kardos for Carleton University.

Camera Installation in Helio Courier Aircraft

Part A - INTRODUCTION

On the morning of 10 October, 1976 we received a call from Cyril Ivimy. He wanted H. Aass Aero Engineering to figure out the best way to install an RC9 Survey Camera in a Helio Courier aircraft. (Exhibit I)

H. Aass Aero Engineering was founded in 1969 by Haakon Aass because he recognized that many private aircraft operators were having difficulty getting modifications approved quickly by the Ministry of Transport (MOT), because of simple red tape delays. Haaken assumed that a small private company could process this paperwork more quickly and this idea was feasible since he had been granted a D.A.R. licence (Design Approval Representative) by MOT. This meant that he could act for MOT and approve or dissapprove modifications. Many of the operators began to consult the new company before they initiated any of their own changes. The operation now consisted of Haakon, myself as Chief Designer, two draftsmen and a secretary. In this position I was usually called into these initial meetings with the customer. I had joined the company in 1971 as a junior draftsman and had worked my way up to the point where I was now Haakon's right-hand man. After one year with the company I enrolled in Carleton University in Mechanical Engineering as a part-time student.

Cyril was Machine Shop Manager for Capital Air Surveys, an aerial photographic company based in Pembroke, Ontario a short distance from Ottawa. He wanted to fly one of the company aircraft down to Ottawa to let us have a look at it.

The Helio Courier, a small six-seater airplane taxied to the front door of our hanger at precisely one o'clock as promised. As Cyril climbed out, he explained that the company had a customer who wanted to lease the plane for a two-year contract in British Columbia, but one of the conditions was that the aircraft should accommodate the RC9. This particular camera is popular with surveying outfits such as "Capital" but its 19" diameter lens barrel makes it awkward to install without major modifications to the aircraft floor structure. To save time, Cyril had removed the floor boards revealing a rather cluttered steel framework. (Exhibit III)

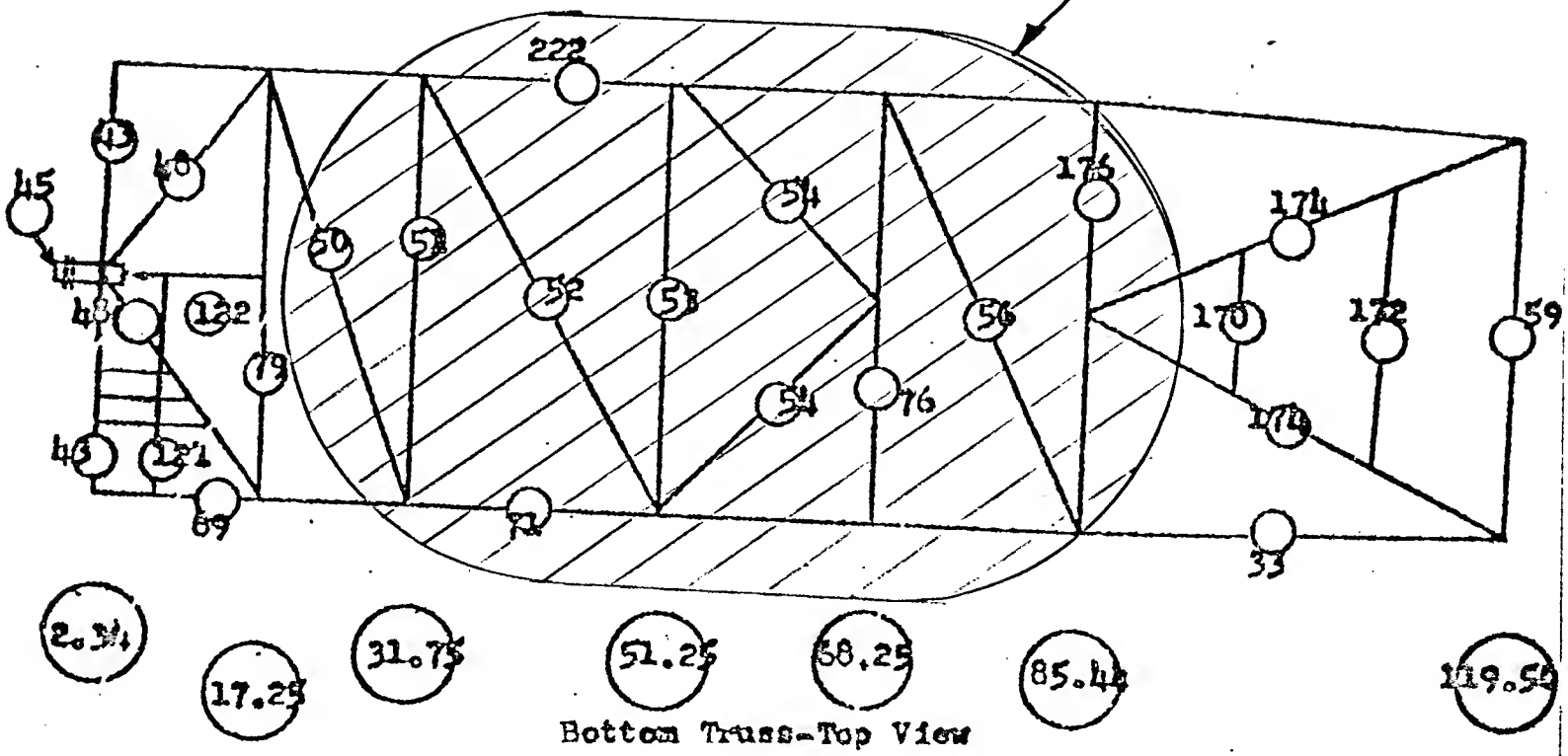
It wasn't long before Haakon and I were poking around the inside of the aircraft, trying to figure the easiest way to do the job without severely weakening the structure. Cyril stated flatly that the only sensible location for the camera was on STA 6 and right in the middle of the aircraft. (This would allow room for an operator behind the camera without crowding the pilot and copilot.) It would mean cutting four of the existing members, one of which was a critical crossfloor tubular beam. Several different configurations were considered and discussed but the easiest method and by far the

quickest was a diamond type set-up. (Exhibit IV) Cyril agreed and Haakon, after insisting that steel gussets were needed at each corner, also agreed.

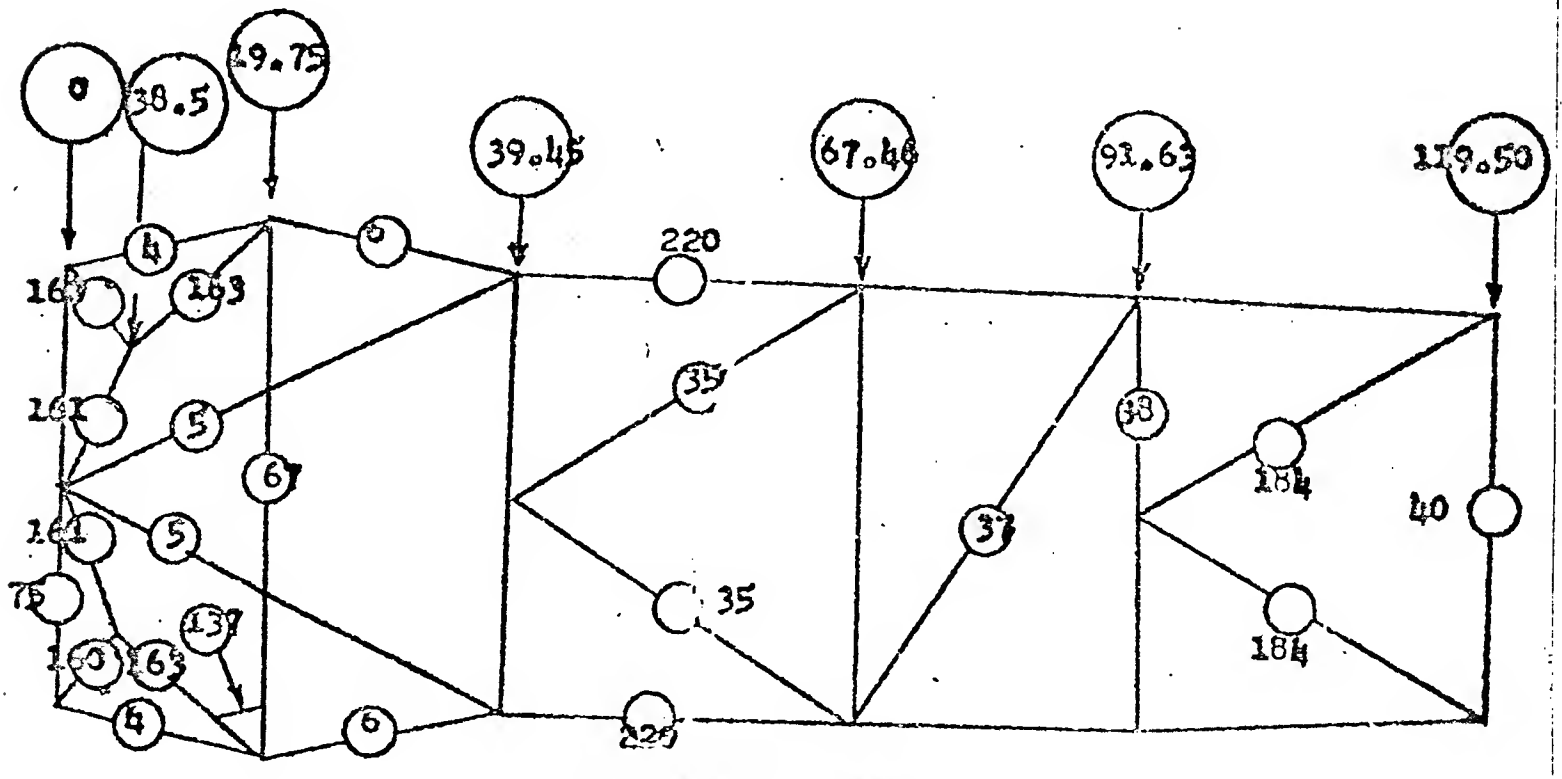
Two different tubings had been used in the construction of the original floor truss: 3/4 diameter X .049 wall for all diagonal braces and 7/8 dia X.049 wall for the main cross tubes. Cyril had neither size in stock back at Pembroke. A quick call to the Ministry of Transport machine shop, just next door, ensured a loan of 12' of 7/8 dia X.049 wall tubing, on the condition that replacement stock was ordered immediately. Haakon explained to Cyril that work on the aircraft was not to begin until we had thoroughly checked the new set-up and prepared a stress analysis report. However, Cyril was guaranteed of a confirmation one way or the other within twenty-four hours. Convinced that everything was ready for his planned modification, he loaded his 12' length of tube into the Helio Courier, climbed in and returned home.

Back at the office, I examined a copy of the sketch I had prepared for Cyril and set about to prove that our proposed re-arrangement of the floor frames was indeed as good as the original configuration. In dealing with such a complicated truss pattern, the only practical way of approaching the problem is to examine deflections under assumed maximum loads. From the aircraft manual, it was obvious that the highest loads would be encountered during landing. These loads would be transmitted from the undercarriage leg directly into STA 5. This then, was the obvious starting point, and I reached for my copy of "Analysis and Design of Flight Vehicle Structures" by Bruhn.

AREA OF FLOOR FRAME AFFECTED BY MOD.



Bottom Truss-Top View



Top Truss-Top View

Station Number

Tube Number

Added 7-30-62

EXHIBIT II

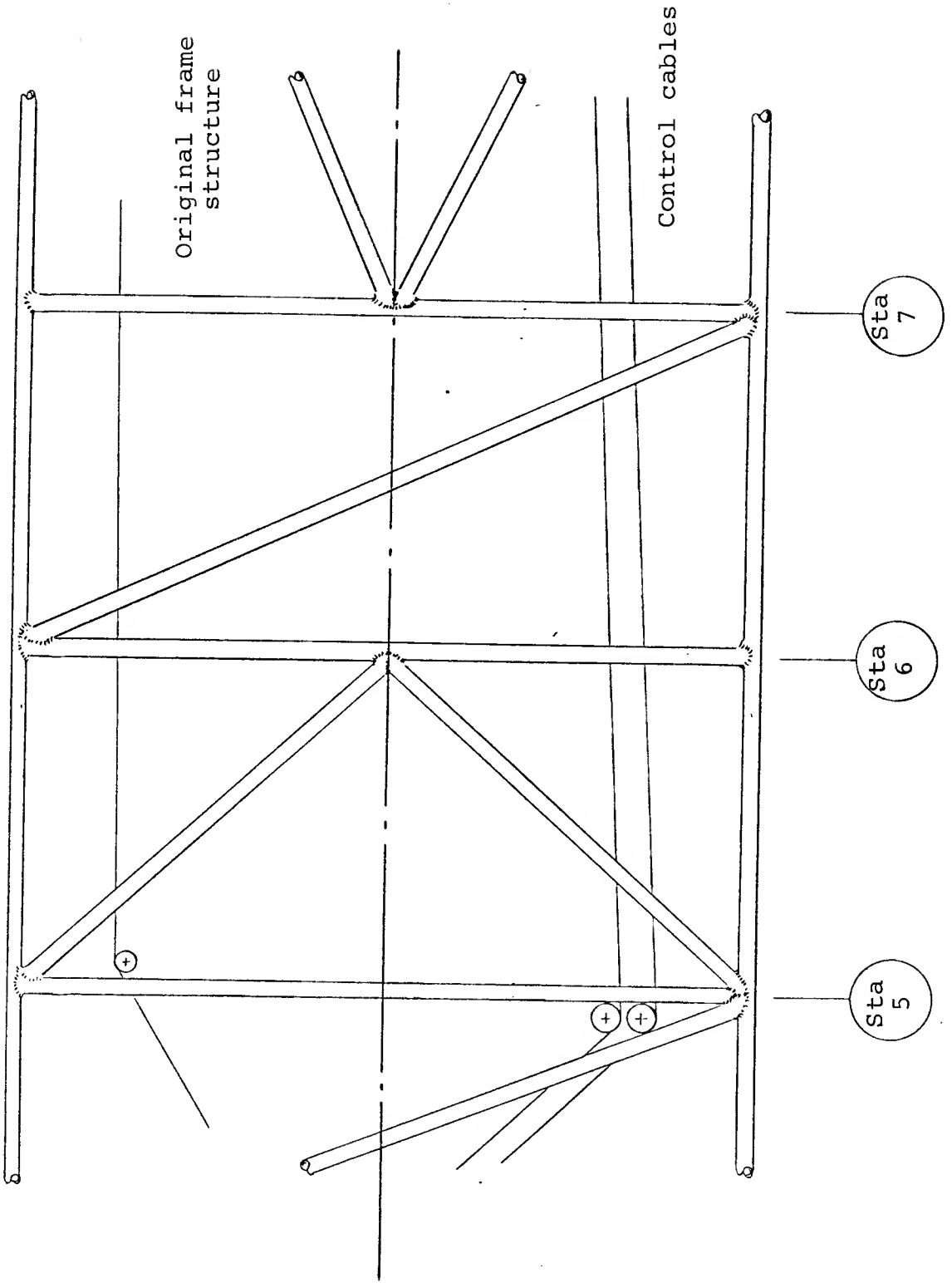


Exhibit III Original Floor Frame Structure

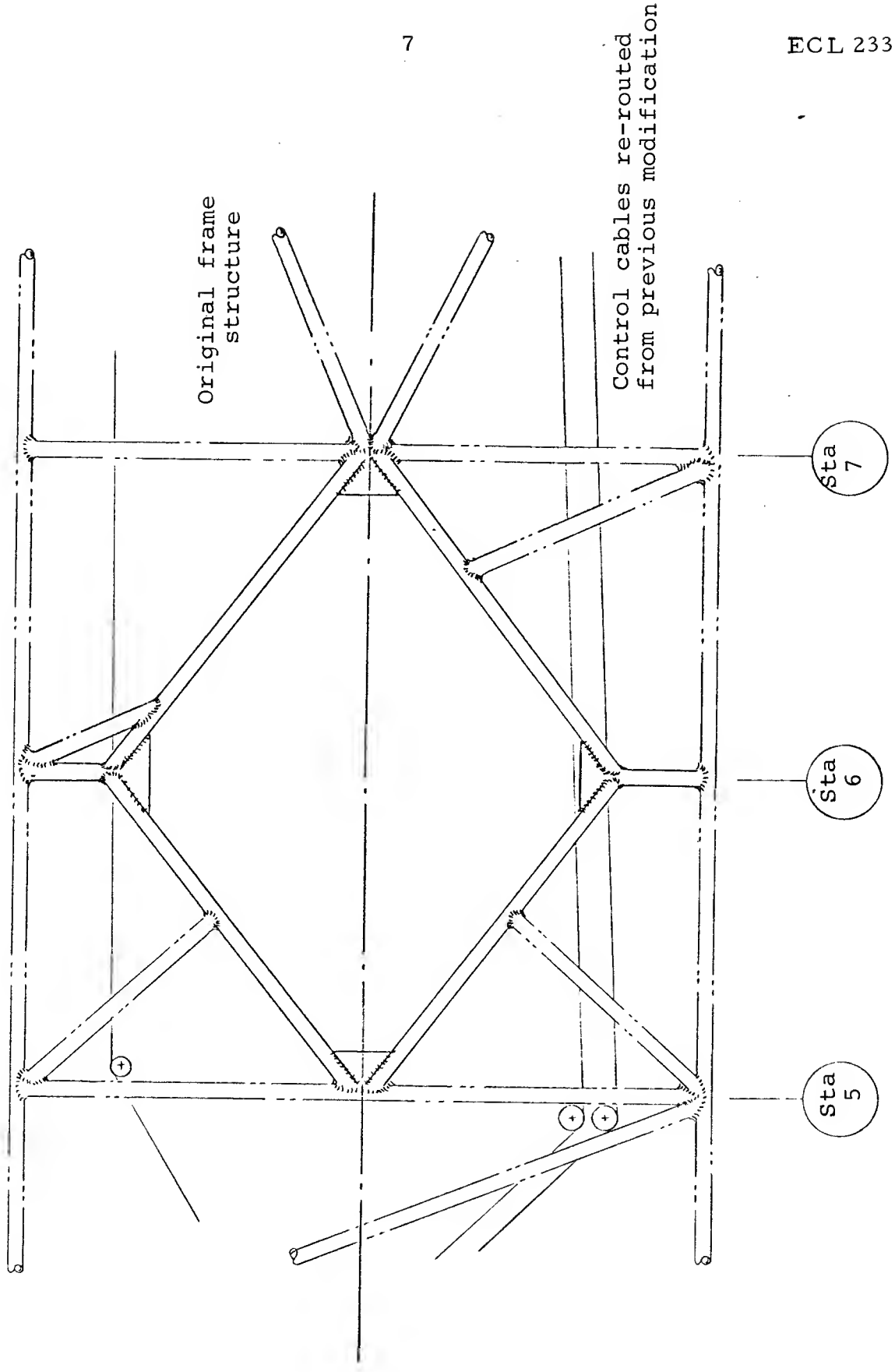


Exhibit IV Modified Floor Frame Structure

CAMERA INSTALLATION IN

HELIO COURIER AIRCRAFT (B)

H.AASS AERO ENGINEERING LTD

Engineering Report No. 1216

Date 12, Oct. 1976

Page 1 of 8

TITLE: CAMERA HOLE MODIFICATION

AIRCRAFT MFG.: HELIO AIRCRAFT CO.

MODEL: HELIO COURIER H. 250

REG. NO.: CF-ZWL

P.O. BOX 182, R.R. NO. 5, HUNT CLUB ROAD, OTTAWA, ONTARIO K1G 3N3 – TEL. (613) 521-0180

Aircraft Owner CAPITAL AIR SURVEYS
KILLALOO, ONTARIO

Work Requested by OWNER

Report prepared by P. A. MOYLAN
H. AASS AERO ENG. LTD.

Checked by

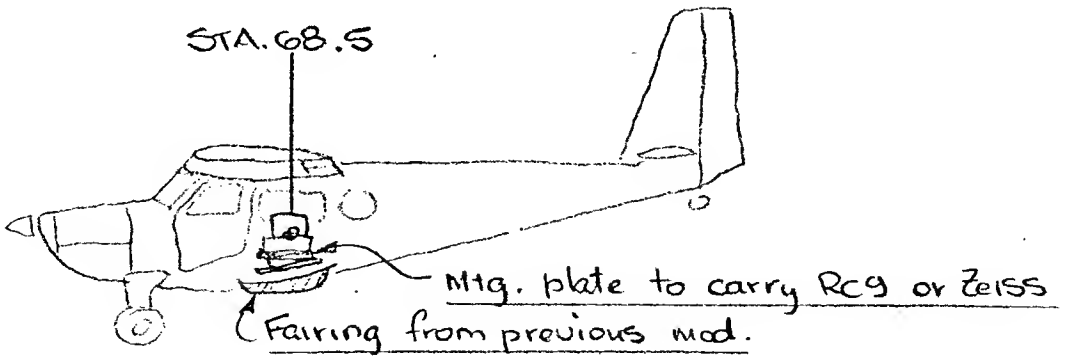
Scope :

The purpose of this report is to provide the engineering required for the approval of a camera hole installation in a Helio-Courier Model H.250 Acft. Reg'n CF-ZWL

References :

1.) Certification Basis : CAR-3 effective 1 Nov. 1949 amended to 16 May 1953 (Cert. 1A8)
2.) Requirements Compliance Program dated 14, Oct 1976 prepared by H.AAE
3.) H.AAE Eng. Report no. 277
4.) Capital Air Surveys Dwg. no. CAS 76-8 Rev. A
5.) Hauts-Monts Inc. Dwg. no. HM 71-01
6.) AC 43-13-1A "Acft. inspection & repair."

Description :



the existing tubular frame is modified as per the referenced drawing to permit installation of the RC-9 & Zeiss wide angle lens cameras. A ¼" aluminum alloy plate used for tying down the cameras is then fastened to the modified framework with 18 # 10-32 bolts & anchor-nuts.

Analysis:

Weight & Balance:

These are covered in the aircraft wt. & balance records forwarded to MOT from Capital Air Surveys where the modification was carried out.

Flight Characteristics:

Since the cross-sectional area of the fuselage remains unchanged, no effects on aircraft performance are anticipated.

Strength Requirements:

In determining critical load factors the following considerations were taken:

Emergency landing: upward $n = 3.0$ 'g'
forward $n = 9.0$ 'g'
sideward $n = 1.5$ 'g'

Maneuver loads:

max. requirements
$n = 3.8$ 'g' (lim.)
Vertical - down
$n = 5.7$ 'g' (Ult.)

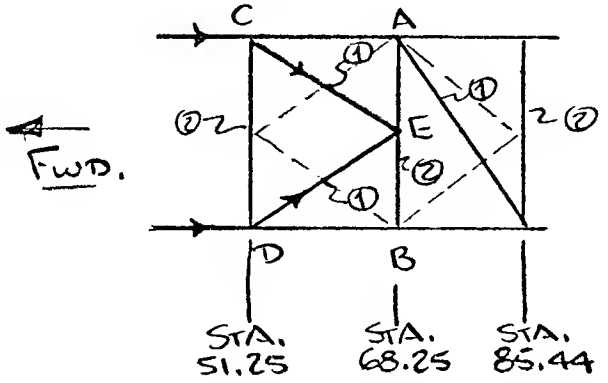
Design & Construction:

General construction, materials & protection is clearly detailed in the referenced drawings.

It is assumed that the highest load concentrations will be encountered at the forward end of the floor frame due to undercarriage loads during landing

Existing Floor Frame Analysis:

This analysis will attempt to show that the modified floor structure (as per Dwg. CAS 76-8) is as strong or stronger than the original tubular frame structure of the aircraft.



① SAE 4130 .75" OD & .035 W.T.
② SAE 4130 .875" OD & .049 W.T.

Look @ member CE:

$A = .07862$ in.^{2} & $L = 24$"
$t = .035$"
$\rho = .2531$ in.
$I = .00504$ in.^{4}

$F_{crit.} = \frac{286 \times 10^6}{\left(\frac{L'}{\rho}\right)^2}$ Long column (Bruhn C 2.1)

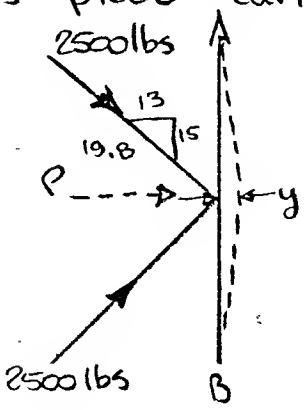
where $\left(\frac{L'}{\rho}\right) = \frac{24}{.254} = \underline{94.5}$

$= \frac{286 \times 10^6}{(94.5)^2}$

$= 32{,}000$ lbs/in.^{2}

∴ Allowable load: $32{,}000 \times .07862 \simeq \underline{2{,}500}$ lbs.

Assuming that this load and a similar load from member DE are both fed into member AB, the deflection of this cross piece can now be calculated.



Total point load on AB:

$$P = \left(\frac{13}{19.8} \times 2500\right) \times 2$$
$$= 1641 \times 2$$
$$= 3282 \text{ lbs.}$$

& $I = .0109 \text{ in}^4$

∴ Deflection of AB:

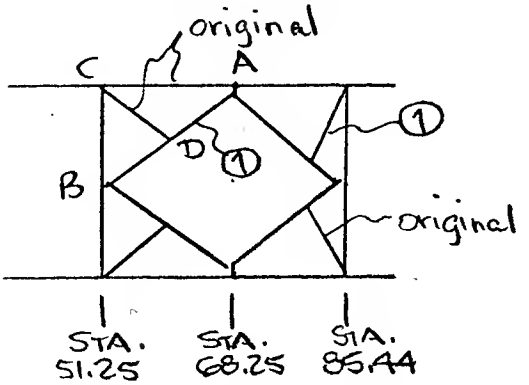
$$y = \frac{Wl^3}{192EI} \quad \text{– fixed ends (welded)}$$

$$= \frac{3282(30)^3}{192(30\times10^6)(.0109)}$$

$$= 1.411 \text{ in.}$$

this deflection is high indicating that the actual load in members CE & DE is less than the allowable of 2500 lbs. However these figures will be used for comparison purposes only. If the predicted deflections of the modified structure are equal or less than those calculated above, then the new configuration can be said to be as good as the original, or, better able to handle the loads applied to it.

Look @ new configuration:

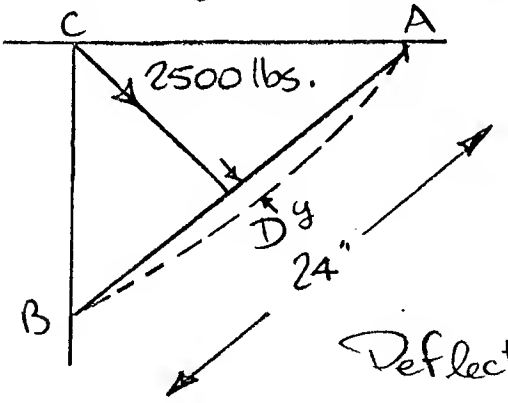


① SAE 4130 .875" OD & .049 W.T.

Modified Area:

- Member CD still carries the same load as before - 2500 lbs.

Look @ member AB:



$A = .127\ in^2$
$t = .049"$
$\rho = .2925$
$I = .0109\ in^4$

Deflection of AB:

$$y = \frac{We^3}{192EI}$$

$$= \frac{2500(24)^3}{192(30\times10^6)(.0109)}$$

$$= 0.550\ in.$$

The deflections found in the original member AB were almost 2½ times as high as those for the new member.

By comparison, it can be seen that the new structure is capable of handling loads similar to those encountered by the original aircraft framework. this conclusion is extremely conservative since the added effects of both the steel gussets and the ¼" mounting plate are ignored. the plate is fastened down with 18 #10-32 bdts & anchor nuts giving:

18 x (2000 lbs tensile/bolt) ---- high --- & this is more than adaquate to react the loads from the camera under 9 'g' consideration.

From these analyses, the modification is considered Satisfactory.

P A Mayla

12, Oct, 76

CAMERA INSTALLATION IN

HELIO COURIER AIRCRAFT (C)

Since this aircraft relied heavily on the body framework for strength, the skin was unstressed (i.e., it was merely fastened to the framework). Because of this, cutting a hole in the aircraft belly would present no additional difficulties. Control cable re-routing, a very touchy problem when it is required, was unnecessary in this instance since all cables had already been moved in a previous modification to permit installation of a radar dish antenna in the same area.

The following day, I telephoned Cyril and relayed my findings to him. I asked him to photograph the completed modification since I would probably not get a chance to go up to Pembroke before the expected completion date.

Two weeks later, Cyril stopped by the office. He had come to "the big city" to buy some hardware supplies and brought with him two photographs of the Helio Courier's new belly floor. (Exhibit V). The photos showed not only that Cyril had followed the sketch almost to the smallest detail, but also showed the skill and workmanship that had gone into the job.

The customer leasing the plane had been extremely satisfied with the modification and was, on that very day, starting his aerial photo work almost one-third the way round the world.

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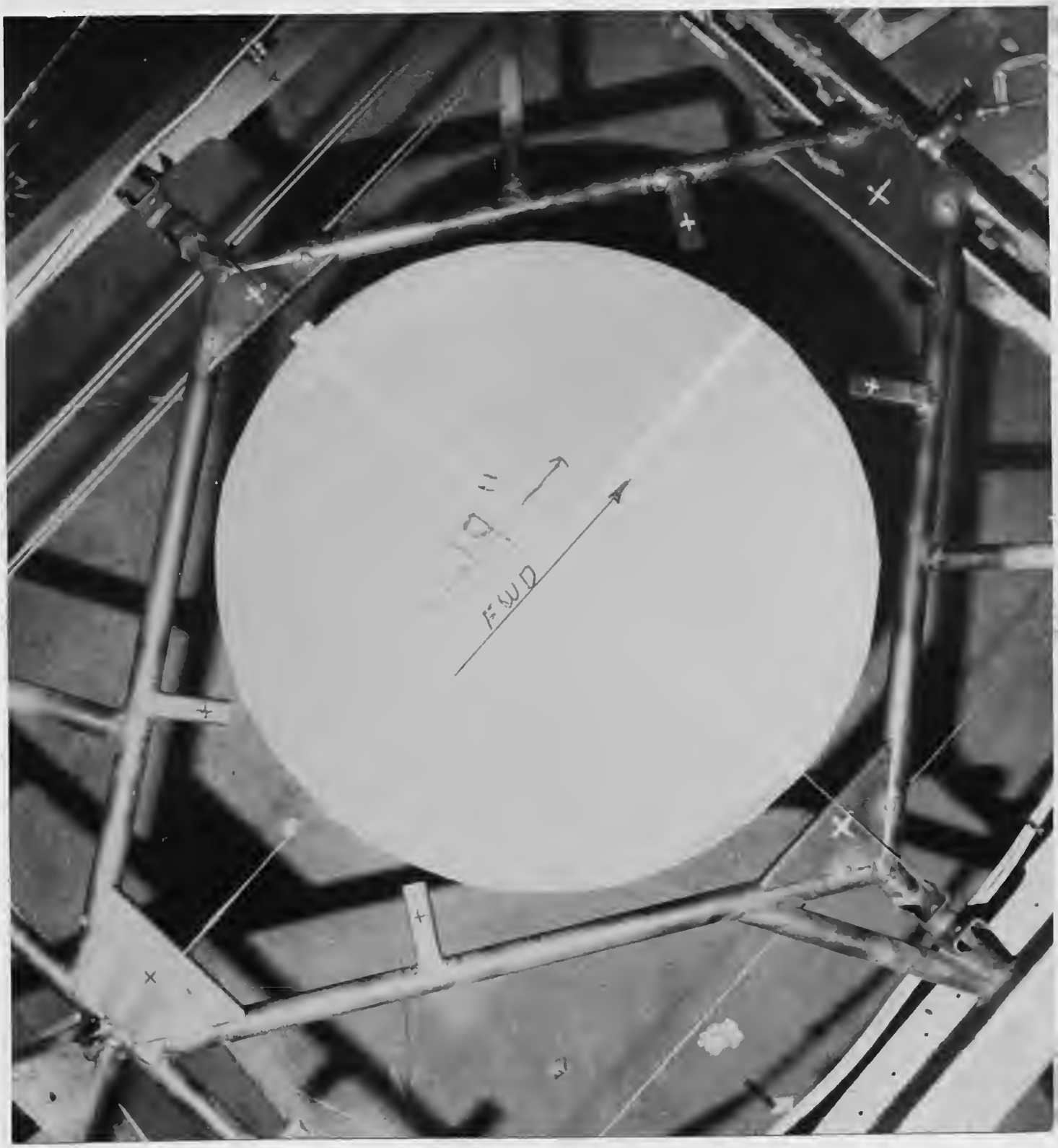

EXHIBIT V